α is a time of loading a wafer to or unloading the wafer to the robot in Step i;

μ is a time of the robot moving from one wafer-processing step to another;

α_0 is a time of the robot unloading a wafer from the loadlocks and aligning the same;

M_{cd} denotes a d^{th} state during the close-down process of the cluster tool; and

M_{ce} denotes a final state during the close-down process of the cluster tool.

2. The method of claim **1**, further comprising a step of determining, by a processor, whether the cluster tool is schedulable at steady state.

3. The method of claim **1**, further comprising a step of determining, by a processor, the cluster tool to be schedulable at steady state if $\vartheta_{max} \le \vartheta_{iU}$ and $\psi_1 \le \vartheta_{iU}$, $i \in N_n$, where $\vartheta_{max} = \max\{\vartheta_{iL}, i \in N_n\}$ and $\psi_1 = 2(n+1)\mu + (2n+1)\alpha + \alpha_0$.

4. The method of claim **1**, wherein the robot waiting time is determined based on a petri net model.

5. A computer-implemented method for scheduling a cluster tool for a close-down process, the cluster tool comprising a single-arm robot for wafer handling, loadlocks for wafer cassette loading and unloading, and n process modules each for performing a wafer-processing step with a wafer residency time constraint where the ith process module, $i \in \{1, 2, \ldots, n\}$, is used for performing Step i of the n wafer-processing steps for each wafer, the method comprising:

determining, by a processor, a lower workload ϑ_{iL} of Step i as follows:

$\vartheta_{iL} = a_i + 4\alpha + 3\mu,\ i \in N_n \setminus \{1\};$

$\vartheta_{1L} = a_1 + 3\alpha + \alpha_0 + 3\mu;$

determining, by a processor, an upper workload ϑ_{iU} of Step i as follows:

$\vartheta_{iU} = a_i + 4\alpha + 3\mu + \delta_i,\ i \in N_n \setminus \{1\};$

$\vartheta_{1U} = a_1 + 3\alpha + \alpha_0 + 3\mu + \delta_1;$

determinig, by a processor, that the workloads are unbalanced among the Steps if $[\vartheta_{1L}, \vartheta_{1U}] \cap [\vartheta_{2L}, \vartheta_{2U}] \cap \ldots \cap [\vartheta_{nL}, \vartheta_{nU}] \ne \emptyset$; determining, by a processor, a robot waiting time ω_i^d, $d \le i \le n$, $0 \le d \le n$ as follows:

1) $\omega_i^d = \omega_i$, $d \le i \le n-1$, $0 \le d \le n-1$ where ω_i is an i^{th} robot waiting time at steady state, and obtained by:

$$\omega_{i-1} = \begin{cases} 0, & i \in F \\ \vartheta_{max} - (a_1 + \delta_1 + 3\alpha + \alpha_0 + 3\mu), & 1 \in E \\ \vartheta_{max} - (a_i + \delta_i + 4\alpha + 3\mu), & i \in E \cap \{2, 3, 4, \ldots, n\} \end{cases}$$

2) $\omega_n^0 = \omega_n$;

$$3)\ \omega_n^d = \vartheta_{max} - \psi_{c(d-1)} - \sum_{i=d-1}^{n-1} \omega_i^{d-1},$$

$1 \le d \le n-1$, where $\psi_{c(d-1)} = 2(n-d+2)\mu + 2(n-d+2)\alpha$, $2 \le d \le n$; and

4) $\omega_n^n = a_n$.

determining, by a processor, a schedule for the close-down process based on the robot waiting time determined;

a_i, $i \in N_n$, is a time that a wafer is processed in the ith process module;

δ_i is the wafer residency time constraint of Step i, given by a pre-determined longest time for which a wafer in the ith process module is allowed to stay therein after this wafer is processed;

α is a time of loading a wafer to or unloading the wafer to the robot in Step i;

μ is a time of the robot moving from one wafer-processing step to another;

α_0 is a time of the robot unloading a wafer from the loadlock and aligning the same;

ω_i^d, $d \le i \le n$, $0 \le d \le n-1$, is the robot waiting time in places q_i during evolutions from M_{cd} to $M_{c(d+1)}$, where M_{cd} denotes a d^{th} state during the close-down process of the cluster tool;

E is $\{i | i \in N_n, \vartheta_{iU} < \vartheta_{max}\}$, where $\vartheta_{max} = \max\{\vartheta_{iL}, i \in N_n\}$;

F is $N_n \setminus E$.

6. The method of claim **5**, further comprising a step of determining, by a processor, whether the cluster tool is schedulable at steady state.

7. The method of claim **5**, further comprising a step of determining, by a processor, the cluster tool to be schedulable at steady state if $\vartheta_{iU} < \vartheta_{max}$ with $i \in E \ne \emptyset$, $\vartheta_{iU} \ge \vartheta_{max}$ with $i \in F$, and $\Sigma_{i \in E}\omega_{i-1} + \psi_1 \le \vartheta_{max}$, and a robot waiting time at steady state is set to make the cluster tool to be schedulable.

8. The method of claim **5**, wherein the robot waiting time is determined based on a linear programming model.

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